Review

- Scientific Notation $2928 = 2.928 \times 10^3$ $.002441 = 2.441 \times 10^{-3}$
- Significant Figures:
  - 2.55×10^{12} means $2.54 \times 10^{12} - 2.56 \times 10^{12}$
- Metric system:
  - Length: Meters Time: seconds Mass: Kilogram
- Conversion of Units: multiply by a representation of one

$$1 year = 1 year \times \frac{365.25d}{1year} \times \frac{24h}{1d} \times \frac{60\min}{1h} \times \frac{60s}{1\min}$$

$$= 1 \times 356.25 \times 24 \times 60 \times 60 = 31557600s$$

0.000000000012
A. 1.2×10^{12} B. 1.2×10^{-12} C. 1.2×10^{-11} D. 12×10^{-10}

In which of these relations will *S* double if *T* is doubled ?
A. S = 10T   B. T = 1/S   C. T = S*S   D. S = 1/T

The development of physics concepts depends heavily on measurements because
A. engineers make all the measurements that are really necessary for physics to survive.
B. new theories are impossible without measurements.
C. our society depends on the employment of people who make measurements.
D. without measurements, incorrect ideas and concepts may seem reasonable.

Suppose you are told that the distance a body travels (d) is given by the product of its speed (v) times the time of travel (t). The mathematical equation for this is
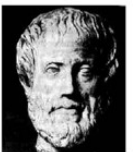A. d = v t.   B. d = v + t.   C. d = v/t.
D. d = t/v.   E. d = 1/(v t).

The erroneous idea that an object needs a force on it to keep moving even at constant velocity was held by
A. Galileo.   B. Aristotle.   C. Newton.

Two bodies have quite different masses, but the net force applied to each of them is the same. The acceleration of
A. each body is the same.
B. the less massive body is larger.
C. the more massive body is larger.

The acceleration of gravity on the moon's surface is about 1/6 of that on the Earth's surface. An object on the Earth is to be taken to the Moon. We can state that, compared to the Earth,
A. the object's mass will be the same on the Moon.
B. the object's mass will be greater on the Moon.
C. the object's mass will be less on the Moon.
D. the object's weight will be the same on the Moon.
E. the object's weight will be greater on the Moon.

Know

1. Newton's 3 laws of motion
2. How to apply Newton's laws in familiar situations
3. The basic units for mass and force
4. How to use vectors in calculating the effects of forces

Understand

1. The difference between the approach of Aristotle versus that of Galileo and Newton in describing the relationship between force and motion
2. The difference between mass and weight.
3. How to calculate the acceleration produced by a given force
4. The effects of friction and air resistance upon motion.
5. How to draw and use a free body diagram

Dynamics: Newton's Laws

- Dynamics is the scientific study of the causes of motion
- The simple activity of just watching the sky has produced many significant advances and results over the centuries.
- The development of modern science started when people tried to understand the regularity of the motions of celestial bodies; an enterprise which took over 2,000 years.
- Newton proposed three laws of motion. These are a set of rules which allows one to calculate how objects move when subjected to forces
- Newton's laws are very accurate and form the physics which governs the dynamics of most of our everyday experiences.

First Theory of Motion

Aristotle

- Aristotle was born in Ancient Greece over 2000 years ago (about 300 BC). Aristotle was the first to think *quantitatively* about motion.

- He reasoned that 'heavier' objects fell to the ground faster than 'lighter' objects.

- Aristotle believed that moving objects must have forces exerted on them to keep them moving.

Galileo

- Galileo was an Italian mathematician, astronomer, and physicist. He was born in Pisa on February 15, 1564.
- Galileo was the first to refine this process with controlled experiments to test specific hypotheses.
- In 1610 he developed the telescope it and used it to discover the satellites of Jupiter and Galaxies
- He invented the thermometer, it worked on the idea that as things get hot they expand and as they cool down they contract.
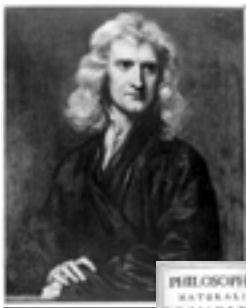
Galileo and the Tower of Pisa

- According to a legend, Galileo dropped two objects with different weights from the Leaning Tower of Pisa.
- Found that all objects fall at the same rate if you can account for air resistance

- Galileo also suggested that no force is needed to maintain motion

Isaac Newton (1642-1727)

- His three laws of motion first appeared in 1687 in his book called Principia.

Newton's First Law or Law of Inertia

- A body remains at rest or moves in a straight line at a constant speed unless acted upon by a force.

- The converse is also true: if an object is at rest or moves in a straight line at a constant speed then the resultant force acting on it is zero

Force

- Force is a push or a pull on an object. A force applied to an object has a tendency to change the shape or the motion of an object.
- Force is a vector quantity, i.e. a quantity which has both magnitude and direction.
- The SI unit of force is the Newton (N), in fundamental units

$$1 \text{ N} = 1 \text{ kg m/s}^2$$

Forces

- All influences on an object from its surroundings are expressed as forces exerted on that object.
- All forces between objects can be placed into two broad categories:
  - **Contact Forces** : are types of forces in which the two interacting objects are physically contacting each other. Examples of contact forces include frictional forces, tensional forces, normal forces, air resistance forces, and applied forces.
  - **Non-Contact Forces** :
    forces resulting from action-at-a-distance

Non contact Forces

- There are four important forces non contact in nature:
  - the force of gravity (drop a brick)
  - the electromagnetic force (electrostatic bells)
  - the weak nuclear force (geiger counter and beta source)
 - the strong nuclear force (geiger counter and alpha source)

Drawing Forces

- To fully describe the force acting upon an object, you must describe both the magnitude (size) and the direction:
- ➢ Draw as an arrow.
- ➢ Length of the arrow is proportional to the magnitude of the vector.
- ➢ Head points in the direction of the vector.
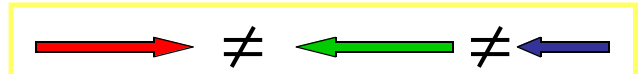
Force and acceleration

- The acceleration of an object is directly proportional to the magnitude of the force

- The acceleration is in the same direction as the force
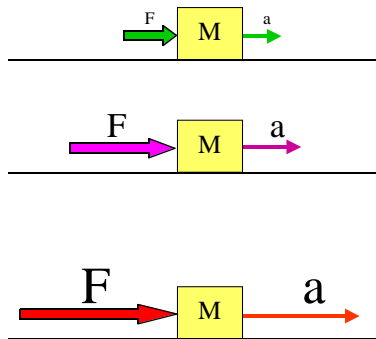
Inertia and Mass

- Inertia is tendency of an object to resist changes in its velocity.
- Mass is a measure of an object's inertia, the property that causes an object to resist changes in its motion

- Mass is the quantity of matter in an object

- Measured in kilograms (kg)   MKS units
  in slugs (sg)   English units (seldom used)
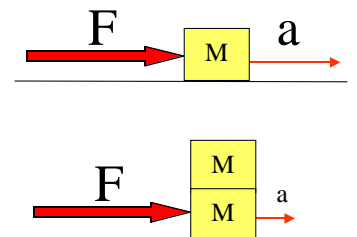
Acceleration and Mass

- When acted on by a force:
  - more massive objects are accelerated less by a given force than less massive objects
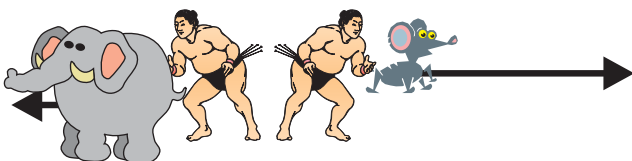
Newton Second Law of Motion

- The acceleration is proportional to the force and inversely proportional to the mass:

$$a = \frac{F}{m}$$

Net Force

- When we apply Newton's FIRST Law of Motion, it is very **important** that we look at the **net** force on an object.
- The **net force** is the **sum** of all the forces acting on an object.
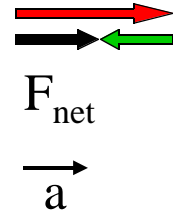
$$F_{net} = \sum F = F_1 + F_2 + F_3 + ...$$

Adding Forces

- Forces are vectors and their direction needs to be taken into account.

$$F_1 \quad \boxed{M} \quad F_2$$

- When adding forces in one dimension:
  - Same direction add
  - Opposite direction subtract
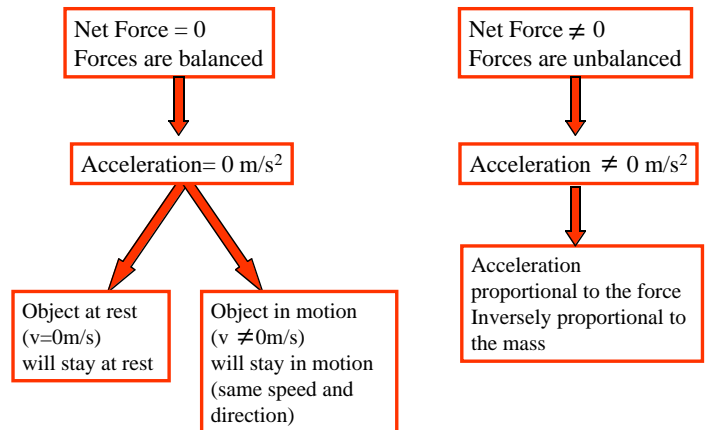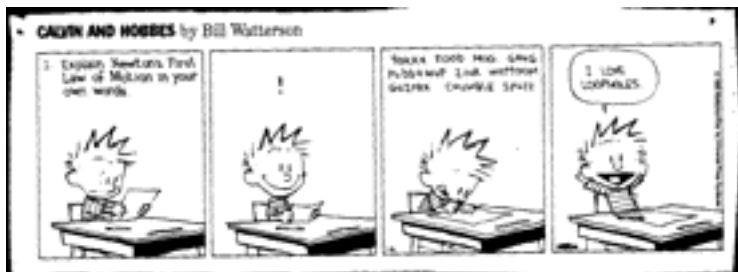
$$F_{net}$$

$$\vec{a}$$

Equilibrium

- "Equilibrium" is the word we use to describe the state when or where the **net force** on an object is **zero**.
- That does not mean there is **no** force at all on an object.
- There may be many forces, but the balance each other or they cancel each other out, for example:

Flow Chart using Newton's II Law

Net Force = 0 Forces are balanced	Net Force $\neq$ 0 Forces are unbalanced

Acceleration= 0 m/s^2	Acceleration $\neq$ 0 m/s^2

Object at rest (v=0m/s) will stay at rest	Object in motion (v $\neq$0m/s) will stay in motion (same speed and direction)	Acceleration proportional to the force Inversely proportional to the mass

Some professors are softies….

CALVIN AND HOBBES by Bill Watterson

- No loopholes in the 106 exams….. Your best bet is to start working on your first assignment!

Newton's Three Laws

- Any object remains at rest or in motion along a straight line with constant speed unless acted upon by a net force

- The product of the mass (m) of any object times its acceleration (a) is equal to the net force (F) acting on the object: **F**=m **a**

- For every force, or action there is an equal but opposite force, or reaction.